



The assessment of lens opacity postmortem and its implication in forensics



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ARTICLE INFO

Article history:

Received 10 November 2012

Received in revised form

2 May 2013

Accepted 20 August 2013

Available online 6 September 2013

Keywords:

Legal medicine

Lens

Postmortem

Lens opacity

Car accident

ABSTRACT

Visual impairment, mostly due to cataracts, has been demonstrated to be an important factor associated with traffic accidents. Although vision screening is standard procedure during licensing in order to prevent motor vehicle accidents, an eye exam is not typically administered after an accident has already occurred.

Postmortem assessment of lens opacity in victims of car accidents would provide helpful information for attesting to the liability of the parties in specific accidents, determining the circumstances of the accident, and developing preventive measures for both drivers and pedestrians alike.

In this paper, we explore the use of different methods and their limitations for assessing lens opacity postmortem. We discuss the possible use and benefits of a simple, but as-yet untested method: retrobulbar translucency. The method would be based on the recording of shadows formed by opaque regions of the lens while the eye is illuminated from the back with a rigid source of light. The efficacy and objectivity of the method, its reproducibility, and the inter- and intra-observer error should be tested before implementing such a technique to be regularly used to determine lens opacity in cadavers.

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1. Introduction

Maneuvering through traffic, both as a driver or pedestrian, represents a complex visual task that requires visual maturity and precision. Therefore the presence of visual impairment conditions in drivers and pedestrians alike can lead to traffic accidents. The relationship between vision impairment and motor vehicle accidents has been examined, with several studies showing that visual impairment can be good predictor of crash involvement. It has been demonstrated that among many visual factors involved in the task of driving, the most significant were glare sensitivity, binocular field loss¹ and contrast sensitivity.^{2,3} Stereoacluity, diminished adaptation to darkness, increased sensitivity to light, and depth perception efficiency of eye movement showed little or no association with crash probability among drivers.¹ Although they do not

seem to be significant predictors of motor vehicle crash involvement independently, the ability to handle traffic demands is greatly reduced when several of these factors are present, thus leading to accidents. Although pedestrian behavior is also dependent on the visual information attained in traffic, current literature lacks research that accurately examines which visual dysfunctions in pedestrians contribute most to their endangerment in traffic. Some studies have attempted to associate poorer peripheral vision in pedestrians with a higher incidence of traffic accidents.⁴ Therefore, vision screening constitutes an important component of traffic accidents prevention efforts. However, the administration of a vision exam after an accident has occurred is not common practice. We believe that more emphasis should be given to this medico-legal issue. Visual screening of both drivers and pedestrians could help elucidate the causes and events surrounding an accident, and clarify the responsibilities of all parties, while at the same time making it a good starting point for further improvements of existing preventive measures. To our knowledge, there are no published studies that deal with visual screening or detection of conditions leading to abnormal visual functions in cadavers.

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Although visual impairment is a very broad term that includes different types of changes starting with changes of the optic nerve (glaucoma), central retina (age-related macular degeneration) or peripheral retina (diabetic retinopathy), cataracts remain one of the most common and well-studied visual impairment conditions that affect the ability to maneuver through traffic. Lens opacity, associated with cataracts, disables the proper refraction of light and the production of a sharp image on the retina. As a consequence, it produces a number of changes in visual function such as cloudy or foggy vision, poor night vision, light scattering, changes in color vision, halos and glare around lights, loss of contrast sensitivity, and field loss. A number of studies have demonstrated the important role of cataracts in driving.^{3,5} Determining the changes in lens transparency postmortem would be a useful starting point in testing the possibility of determining visual impairment conditions in a cadaver. The method in question should be easy to apply, accessible and affordable for all forensic experts, and should guarantee high reproducibility, little inter-observer error, and minimal invasiveness.

2. Eye examination in cadavers

In forensic practice, pathologists have often used ocular enucleation to inspect and illustrate in more detail the condition of the eye postmortem.⁶ This method is very invasive and today's forensic practitioners prefer to avoid it due to ethical and cosmetic factors. If they do perform it, they should describe the shape, transparency, and position of opacities when inspecting the condition of the lens. The lack of standard descriptors or scales to facilitate this task makes any comparison between different results difficult and unreliable.

It is only in the last few years that forensic practice began to rely on ophthalmological endoscopy as a valuable tool in forensic autopsy, revealing its usefulness in achieving objective data regarding traumatic lesions and fundal status.⁷ There has not yet been a study conducted in order to test the postmortem condition of a lens with the help of ophthalmic endoscopy. In fact, lens opacity was considered one of the major limitations in conducting forensic ophthalmic endoscopy because it affected the quality of fundal imaging,⁸ but it has been tested for visualization of modern intraocular lenses in eyes obtained postmortem.⁹ Therefore, it would be very interesting to test its usefulness in the objective description and categorization of lens opacity. While the necessity for an expensive ophthalmic endoscope and for a qualified and trained person to conduct the examination could represent a problem for forensic practitioners, more simple and payable methods should also be investigated.⁸

Besides testing the usefulness of ophthalmic endoscopy, another method that could be interesting to test is retrobulbar translucency, which would be easy to apply, with less associated cost than endoscopy because it requires only a rigid source of light (an endoscope) and a camera or flexible microscope that allows for the taking and storing of images. The examination should start by entry into the cranial cavity and removal of the brain by conventional means. The access to the eye should be made through the posterior apex of the triangle that forms the roof of the orbit. The entry point should be identified with the help of the ophthalmic nerve and the endoscope should enter the eye superior to the nerve to allow for a more standardized approach in different specimens (Fig. 1). Such an approach is very convenient because, unlike the enucleation method, it does not interfere with the physical appearance of the deceased. The source of light should be directed from the back of the eye to the pupil and a strong beam should be released through the eye. In this way shadows produced by cataracts should be easy to detect and store. The photographing of produced shadows should be done in such a way as to disable any interference by external and surrounding sources of light. In this way, the forensic

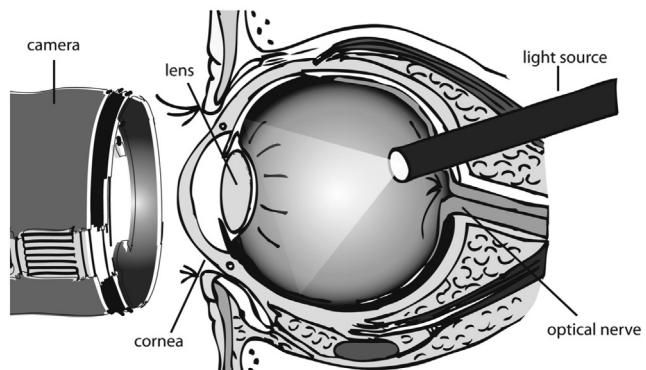


Fig. 1. Retrobulbar translucency – a possible use of the method that could help in the assessment of lens opacity in cadavers.

pathologist would be able not only to detect, but also to save the image of the observed changes in the lens transparency, which can be used as a reference point for future comparison. The proposed retrobulbar approach would be a good way of taking histological samples of the posterior eye segment and optical nerve, which could clearly evidence other visual impairment conditions (such as degenerative changes) without disrupting the appearance of the deceased, which is very important to family members.

Among the factors that could limit the development and application of a method that aims to test lens opacity in cadavers are the degenerative changes that take place postmortem. It is known that the eye, following death, undergoes a number of degenerative changes including cornea opacification, dull cornea and softness of the eye.^{7,10} The lens does not seem to be subject to rapid postmortem changes, but the blurring of the cornea could pose a problem with regards to the method in question as it does with ophthalmoscopy. In addition, Lynerupp noticed that, after a three-day period in the human corpse, the lens becomes more fluid and is no longer intact in its capsule, and therefore inadequate to extract and analyze.¹¹ Therefore, the method should be time-limited to avoid the interference of postmortem changes with the final outcome.

Independent of the method chosen for assessing it, making an objective scoring and grading system of the lens opacity (associated with the level of visual impairment in the living) and its contribution to motor vehicle accidents would be one of the main steps in the analysis of lens opacity for forensic purposes. A simple comparison between the results obtained by a comprehensive postmortem analysis of the lens and the developed scoring system would provide information about the level of lens-dependent visual disability in a victim. Before that, the reproducibility and congruence between the results of the proposed methods should be tested, and studies that assess the relationship between the observed stages of lens opacity in drivers and pedestrians with their unsafe behavior in traffic should be performed.

3. Conclusion

The postmortem determination of lens opacity would provide helpful information that could be used during legal proceedings while attesting to the liability of the parties. Motor vehicle accidents are often associated with alcohol/drug consumption, speeding, risky overtaking, etc. Although only a small percentage of fatal motor vehicle accidents in the western world are directly caused by visual impairment, it must be taken in consideration as a possible concomitant or triggering factor. While other eye conditions would need to be considered in order to assess causality/liability in traffic accidents, we believe that testing the usability of the

approaches presented here would comprise a good start to the development of a valid and reproducible method for testing visual impairment conditions. The postmortem evaluation of the lens would provide the added benefit of associating different forms and stages of cataracts with accident risk, thus affording new information relevant to the development of preventive measures for both drivers and pedestrians. Such an approach would be also a good complement to clinical data, and fundamental in cases where there is no medical documentation.

Ethical approval

None declared.

Funding

No grants or financial support has been obtained for this manuscript.

Conflict of interest

We hereby acknowledge that there is no financial, ethical or other conflict of interest for any of the authors regarding the material discussed in the manuscript entitled "The assessment of lens opacity post-mortem and its implication in forensics" submitted to the Journal of Forensic and Legal Medicine.

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